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It is interesting to note that continued roots have their converse, which by analogy would be called *Continued Powers.* Thus the four expressions following are equivalents, each being an expression for the roots of the equation $x^2+px=q$.

$$\cfrac{q}{p+\cfrac{q}{p+\&c.}}, \qquad -p+\cfrac{q}{-p+\cfrac{q}{-p+\&c.}}, \qquad \sqrt{q-p\sqrt{(q-\&c.)}}, \quad \frac{q}{p}-\frac{1}{p}^2\left(\frac{q}{p}-\frac{1}{p}^2\left(\frac{q}{p}\&c.\right.\right.$$

LEAST SQUARES.

BY R. J. ADCOCK. (CONTINUED FROM P. 184, VOL. IV.)

LIMITS OF ERRORS.—By first and second formulas on pages 183 and 184,

$$p=\frac{n\,{}^{*}}{4\pi m\,S(d_1^2)^{\dagger}} \tag{1}$$

is the probability that any point of the total number $4\pi S(d_1^2)m$, shall be at or on any required point, line or surface, and

$$p=\left(\frac{n}{4\pi m\,S(d_1^2)}\right)^n \tag{2}$$

is the probability for n points of the same number. Each of which values of p is greatest when $S(d_1^2)=$ a minimum.

Let it be assumed that, in different sets of n points similarly observed, the minimum $S(d_1^2)$ remains unchanged, or that the total number of points, in determining the probability in (1) or (2), remains the same, which is nearly true in practice and more nearly so as n is increased.

Now the number of points which are at the distance l from any point is $4\pi ml^2$, therefore, under the assumption, the probability that a random point shall be at the distance l from the foot of any one of the normals $d_1, d_2 \ldots d_n$, is

$$p=\frac{4\pi mnl^2}{4\pi m\,S(d_1^2)}=\frac{nl^2}{S(d_1^2)}\ldots(3) \quad \text{Hence } l=\sqrt{\left(\frac{pS(d_1^2)}{n}\right)} \tag{4}$$

is the limit within which equal normals or errors are situated when their probability is p. $p=1$, gives $l=\sqrt{[S(d_1^2)\div n]}\ldots(5)=$ what is called the mean error, that is, if each error is of the same magnitude it will be $\sqrt{[S(d_1^2)\div n]}$. And $p=\frac{1}{2}$, gives $l\,\sqrt{[S(d_1^2)\div 2n]}\ldots(6)$ which is called the probable error of a single observation, that is, if $\frac{1}{2}$ the errors are equal, each will be $\sqrt{[S(d_1^2)\div 2n]}$. Hence this value should include one half of the n errors, and a single one is as likely to be less than, as to exceed it.

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[*] Instead of 1 as the numerator in the formula near the bottom of p. 183, Vol. IV, read n. Also, for π in the same formula and in the two formulas on p. 184, read 4π.

[†] $S(d_1^2)=d_1^2+d_2^2+d_3^2+\ldots+d_n^2$.

And in like manner $p=1\div q$, $l=\surd[S(d_1^2)\div nq]$, means that if $1\div q$ of the n, or $n\div q$ errors, are equal, each will be this value of l, and that these are as likely to be less than, as to exceed $l=\surd[S(d_1^2)\div 2nq]$.... (7), which is therefore the probable error $1\div q$ of the n errors. Hence $l=\surd[S(d_1^2)\div 2n^2]$ .... (8) is the limit which includes $\frac{1}{2}$ of $1\div n$ of the n errors, that is, the limit which includes $\frac{1}{2}$ of one error and therefore the least one of the n, which may be taken as the probable error of the point, line or surface determined by $S(d_1^2)$ = a minimum = a constant also for different sets of n similar observations, since an error in the starting point and in the same direction in which a line is measured entails the same error upon the estimation. Wherefore, from (7) and (8), when the probable error for one observation is $\surd[S(d_1^2)\div 2n]$, that for m is $l=\surd[S(d_1^2)\div 2mn]$.

Ultimate Proposition in Attraction.—If the points of every particle of matter attract the points of every other particle of matter, then the resultant attraction between any two particles, whose dimensions are infinitely small in comparison with the distance between them, will be directly as the product of their masses and inversely as the square of the distance between them.

That it is as the product of the masses, when the distance is constant, results from the consideration that if the density of one be increased or diminished in any ratio, the number of attracting points and forces is increased or diminished in the same ratio without affecting their directions; the force of attractton varying then as the mass of one when the other is constant must vary as the product of the masses when neither is constant.

That it is in the inverse ratio of the square of the distance, follows first, from the fact that any two points of matter of the same density, attract each other with a constant force for all distances, because the point of application of a force may be any where on its line of direction, distance being a quantity of a different kind has no effect on force; second each point of each particle being a centre of attraction for all other particles, the number of these equal forces applied between two particles is directly as the product of their masses and inversely as the square of the distance between them, as a necessary consequence of their situation.

R. J. Adcock.

[By request of Mr. Adcock, the above note is re-stated, as amended by him and returned to us with the "proof" to which we referred at page 190, Vol. IV.

In proof of Mr. Adcock's proposition, and as a *correction* of our assumption at p. 190, Vol. IV, that the attraction is as the sum of the masses, we